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The Design of the Zwolle Cable-stayed Bridge - Integrating Engineering with Aesthetics

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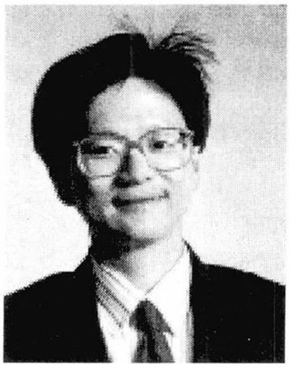

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Abstract

Between Stadshagen and Zwolle in the Netherlands, a landmark bridge structure now graces the environs of the Zwarte Water and stamps its authority on bridge aesthetics. As construction progresses the striking profile of the Zwolle Bridge emerges from the Zwarte Water and captivates the admiration of local residents and visitors alike. At dawn and in the golden sunset, the scene is one of the most spectacular of all bridge sites. Maunsell Ltd, the specialist sub-consultant to Grontmij Infrastructure, is responsible for the design of the cable-stayed bridge and the east approach span.

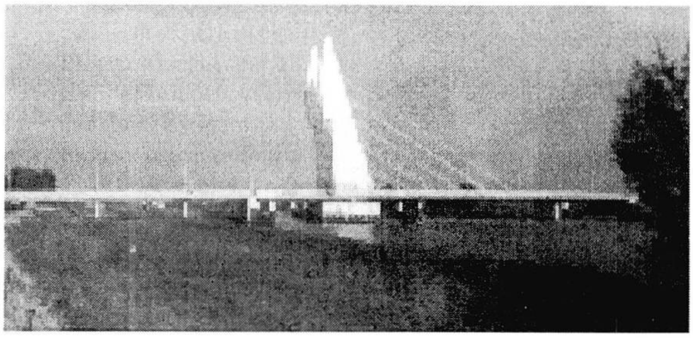

Fig 1 – Maximising the Intensity of Light

The Zwolle Bridge is an asymmetrical cable-stayed bridge with a single main span of some 56m with a continuous east approach span of 25m. The project also consists of a west approach viaduct and a bascule bridge. The steel bascule span closes the 18m gap between the cable-stayed main bridge and the west approach viaduct. The superstructure consists of twin longitudinal spine beams 1000mm deep, with a concrete slab varying in depth from 250mm to 330mm, and cross girders at typically 4375mm centres. Longitudinal bending, shear and axial compression are primarily resisted by the twin spine beams and top flange. Transverse actions between the cable planes are resisted by the stiffening cross girders. The superstructure is monolithic with the bascule chamber, which forms the substructure to the pylon, and is continuous over the intermediate pier in the east approach span.

The cross section of the superstructure, as well as the highway layout over the deck, are asymmetrical. The design allows for future widening of the deck on one side to accommodate a revised highway cross section.

The shape of the pylons is architecturally unique and brilliant. The flow of forces are well communicated by the shape and form. In order to achieve a clean profile, the twin leaf shafts are designed to remain stable without the need for cross bracing. The pylon shafts are at a maximum height of 43.35 metres above deck level. For structural efficiency they are inclined backwards to provide counterweight. To control the tension in the rear face, each pylon shaft is prestressed vertically with six cables. The rear face of each pylon shaft is notched to accommodate the bascule sspan in its opened position. The notches add further character to the profile and provide visual relief where it is warranted.

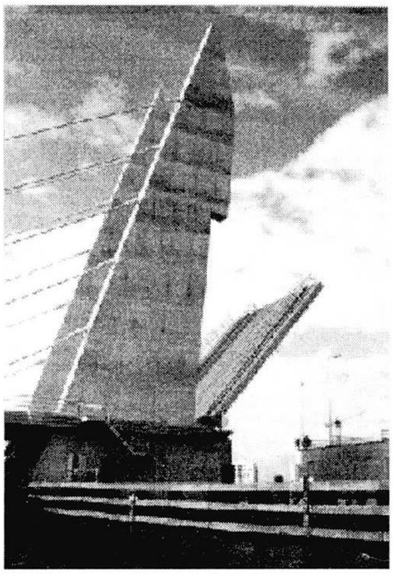

Fig 2 - Stillness versus Motion

There are five cables to each pylon shaft and each cable is threaded obliquely through, in deviator pipes, and anchored at recesses in the rear face to permit access to cable anchors for inspection, maintenance and potential re-stressing. At the other end, the cables are anchored on the underside of the deck slab, outside the longitudinal spine beams girders, at every second cross girder. The in situ concrete anchorages are functional as well as being a deliberate architectural statement. They are integrated with the grillage beam system, thus accommodating the geometric variation and injecting the cable loads directly into the main beams.

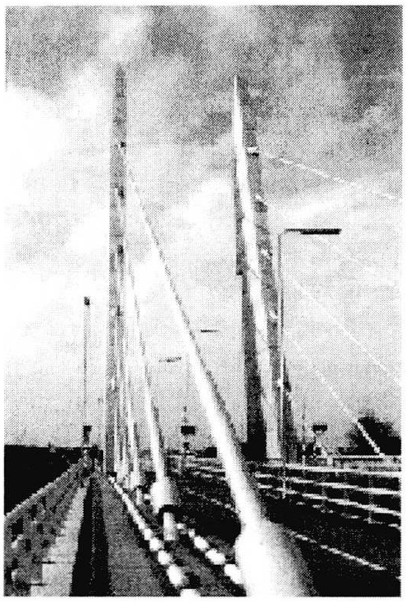

Fig 3 - Tour de Force

Pylon construction was completed in some four months. The pylon shafts were constructed in 4.5m lifts at an average rate of one pour per pylon per week. Once construction had reached 22.5m above deck level each shaft was prestressed. Pylon construction was completed after grouting of the prestressing tendons.

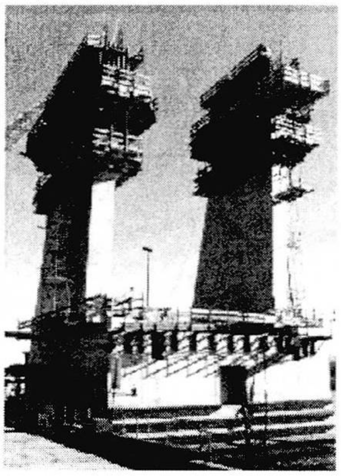

Fig 4 - Construction of Pylon Shafts

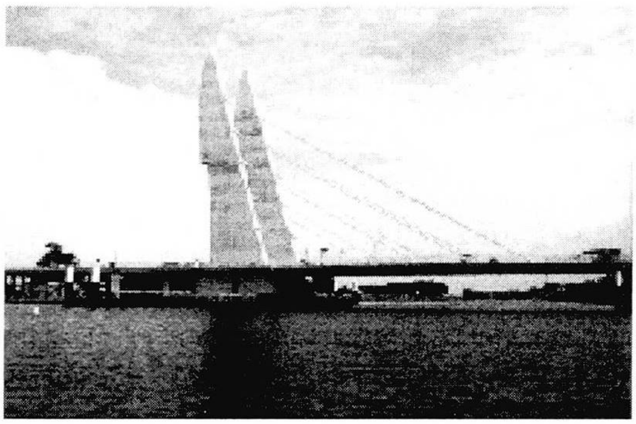

Fig 5 - Clarity, Light, Space & Water